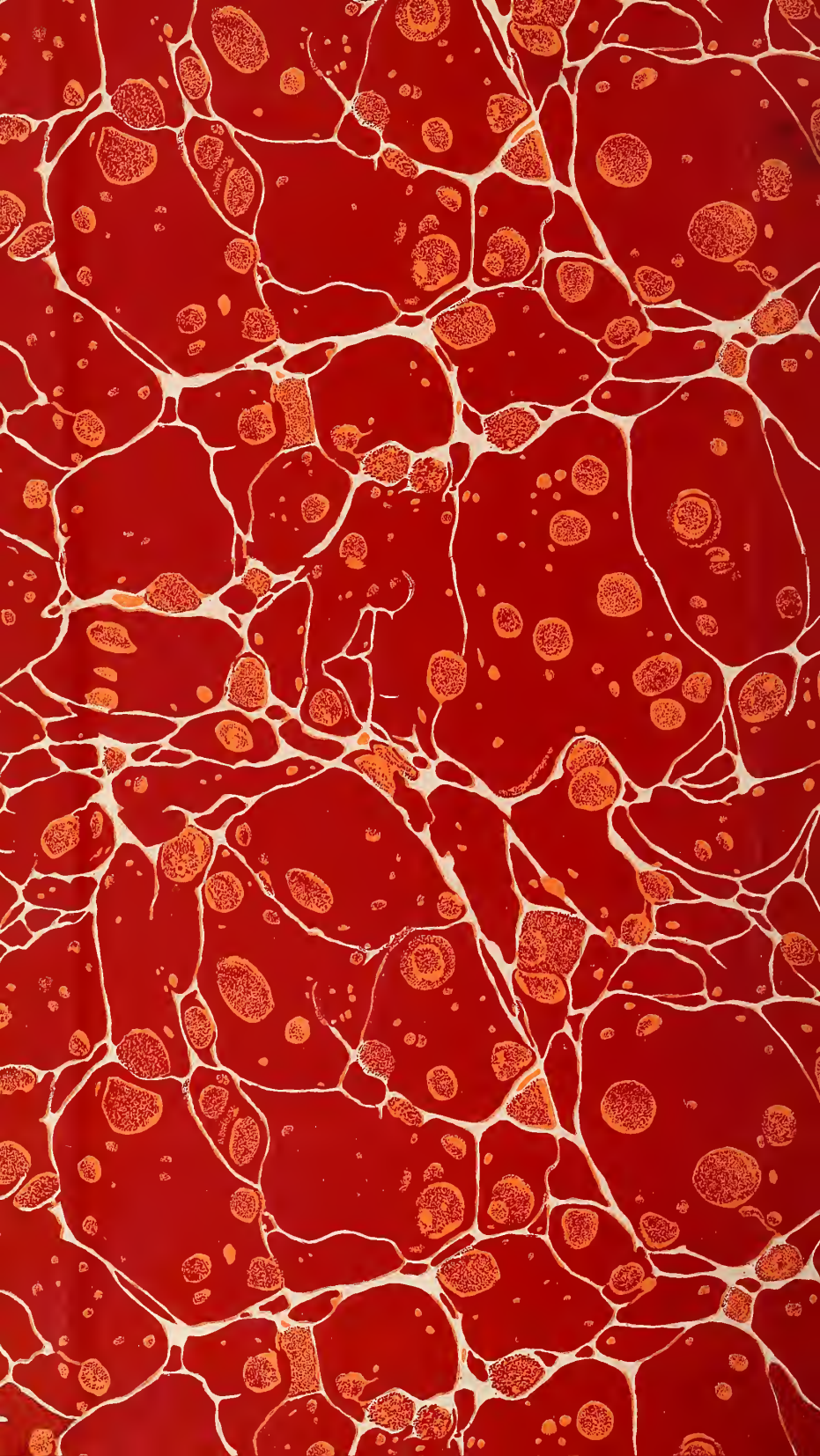


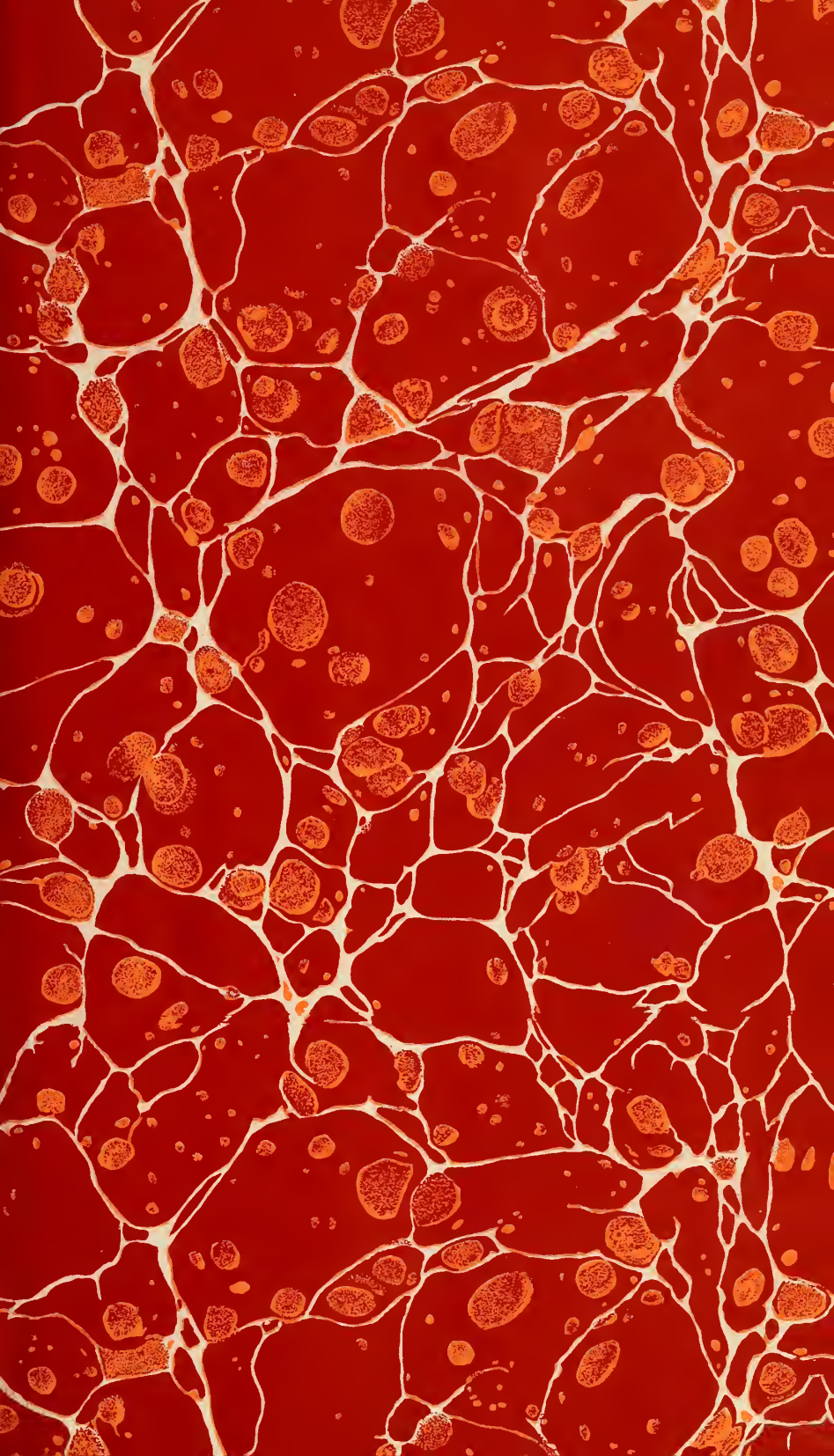
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**HAWAII AGRICULTURAL EXPERIMENT STATION**

**HONOLULU, HAWAII**

Under the supervision of the  
**UNITED STATES DEPARTMENT OF AGRICULTURE**

**REPORT OF THE**  
**HAWAII AGRICULTURAL EXPERIMENT**  
**STATION**

**1926**



**Issued April, 1927**



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## HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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<sup>1</sup> Appointed Dec. 3, 1925.

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# HAWAII AGRICULTURAL EXPERIMENT STATION HONOLULU, HAWAII

Under the supervision of the  
UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D. C.

April, 1927

## REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1926

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### SUMMARY OF INVESTIGATIONS

By J. M. WESTGATE, *Director*

The station continued its established policy of fostering the development of diversified agriculture in the islands. Among the minor crops, pigeon peas and edible canna are giving most promising results in yield and ability to increase the agricultural output in sections that are not adapted to the production of sugar cane and pineapples, the two local major products. Pigeon peas are successfully grown on ranches and smaller farms and can probably be grown also to advantage on the marginal lands of plantations where sugar yields are almost too low to be profitable. The pigeon pea is expected to demonstrate its value as a forage crop on these marginal lands and also to improve soil fertility to such an extent as to make sugar-cane production there considerably more profitable than it now is. Edible canna has proved its ability to produce yields at altitudes that are not suited to sugar-cane cultivation and in localities that are too wet for pineapple production. Edible canna can be grown without competing with the two major crops as regards occupation of the land, and gives promise of adding a starch-producing industry to the islands with the development of suitable markets for the profitable outlet of the commercial product.

Work of the horticultural division was devoted largely to introducing new and improved varieties of economic plants, including citrus, breadfruit, grapes, avocados, dates, and Persian walnuts. Considerable work was done in an endeavor to develop more effective methods of budding and grafting. Approximately 40,000 small plants and packages of seed of improved varieties were distributed to local growers for trial. Variety tests are under way with the more promising

species of tropical and subtropical plants. The horticulturist served as chairman of the committee on fruit exhibits at the Territorial fair, which was held from August 31 to September 9, 1925, and as one of the judges of the Star-Bulletin school-garden contests.

Agronomic work was directed primarily toward the development and improvement of locally grown diversified crops. It was greatly hampered by the unusually dry weather, which seriously curtailed the available water supply for irrigation. Four major projects under investigation and experiment included (1) root crops for man, stock feed, and starch production; (2) ginger culture; (3) Mendelian studies with Guam corn hybrids; and (4) lettuce breeding to develop a hardy solid-headed strain for the lower altitudes. Experiments were made with vegetables of oriental origin to determine their cultural requirements and possible place in the dietary of the people of the various nationalities living in Hawaii. Numerous small lots of seed and vegetative planting material of various crops were furnished to interested growers. In addition to his regular duties, the agronomist continued to serve as secretary at the poultry show of the Territorial fair, and to assist local poultrymen in problems connected with the industry. In cooperation with the extension division of the University of Hawaii, he gave a series of lectures on poultry keeping on Kauai for the benefit of assembled groups of farmers. He also made a trip to Molokai during April to study the present status of cantaloupe and watermelon production on that island.

The solution of technical problems arising in connection with the edible canna industry is regarded as one of the major projects of the chemical division. Considerable time was devoted to the crop because the starch is thought to have potential possibilities for commercial use. The tri-local experiment with vegetables, grown from the same seed stock in Hawaii and in different places on the mainland, was completed. The results show no essential differences in the mineral constituents of Hawaiian as compared with mainland-grown vegetables. The making of jams, jellies, and glacés was continued to learn the best methods of preserving Hawaiian fruits, and methods were devised for testing fruit juices for jelly-making qualities.

The extension agent for the island of Hawaii again assisted farmers in solving problems in crop production and marketing, and in extending the culture of the edible canna, distributing locally grown pasture and forage crop seed, seedling trees for windbreaks, and literature dealing with agricultural topics, obtaining improved varieties of seed from the mainland, and establishing grass demonstration plats. He also assisted very materially with the boys' and girls' club work and Boy Scout activities, acted as chairman of the agricultural section of two school fairs, and as judge in the school-garden contests. During the year he traveled approximately 10,000 miles, mostly by automobile, visiting farmers in different parts of the island.

Boys' and girls' 4-H clubs were organized and conducted on the islands of Oahu, Maui, Hawaii, and Kauai. (Fig. 1.) The activities were carried on in cooperation with the Territorial department of public instruction and the International Institute of Honolulu. New 4-H sewing, gardening, and potato clubs were organized in Hamakua-poko, Maui; garden clubs in Lihue and Koloa, Kauai; cooking clubs in Hilo and Honokaa, Hawaii; and sewing and agricultural clubs in Pepeekeo, Ookala, and Pauilo, Hawaii. Club work was conducted

in the same communities as last year, but on a more extensive scale and with a larger membership than formerly. A total of 1,320 children enrolled, with 1,070 members, or 81 per cent, completing their projects. The club leader made three visits each to Maui and Hawaii, and one visit to Kauai during the year, and gave about 75 per cent of her time to field work, attending club meetings and making personal visits to club members, and devoted the rest of her time to office work at the station.

At the Haleakala demonstration farm, which is conducted to determine what kind of agricultural practices are best adapted to that part of the island in which the farm is located, approximately 149 varieties of 42 kinds of crops were tested, and numerous small lots of planting material were furnished to homesteaders and others for trial.



FIG. 1.—Club contestants and demonstrators. A, Canning team, Oahu; B, canning and cooking club, Honolulu; C, canning team, Maui; D, poultry-judging team, Lillian Baptist, Helen Donaghho, Harry Medeiros, and judge, J. O. Dale, of the University of Hawaii; and E, Kineuyo Mloken, sewing-club contestant, Maui

## REPORT OF THE HORTICULTURAL DIVISION

By W. T. POPE

Cultural experiments were continued with certain crops which are commercially important or give promise of becoming so, but normal plant growth was maintained only with difficulty because of the drought that prevailed throughout the year and the general shortage of water for irrigation. The experiments are divided into two classes, the first including the more permanent, perennial crops like citrus, mango, avocado, banana, litchi, grape, and Macadamia nut, and the second, annual crops, such as tomato, pohla, and roselle.

## CITRUS FRUITS

The citrus orchard at the central station was begun some years ago and now contains many valuable varieties of citrus fruit trees, including oranges (14 varieties), lemons (5 varieties), limes (4 varieties), pomelo (11 varieties), mandarin (6 varieties), and 7 other miscellaneous citrus of different species. The orchard represents the largest collection of citrus varieties in the Territory, and is of value as a source of propagating material. The results of experiments in this orchard have shown the possibilities of producing certain kinds of citrus fruits in Hawaii. The orchard was thoroughly pruned and sprayed during the year. The continuous dry weather interfered with regular cultivation and prevented the growing of desirable cover crops to improve the soil and protect it against erosion in winter.

A number of introductions were received from Florida, California, and Australia, the most important varieties being the Cleopatra mandarin and the trifoliate orange, which are recommended for seedling rootstock material. Propagating material of several varieties of grapefruit was received by mail in excellent condition.

## MANGOES

The old mango orchard contains trees of 18 varieties, most of which are known locally as (East) Indian varieties. The trees were too closely planted, and in order to give them more air and light some of the least desirable varieties were removed during the year and others were rather severely pruned. The orchard was sprayed with Bordeaux mixture for the prevention of mango blight (*Glæosporium mangiferae*), which may prove to be a serious menace at blossom time if there is considerable rain. The fungus fortunately did not appear this year, except in very mild form on the young fruits of the Brindabani. At the station this variety is usually attacked by the fungus. (Fig. 2.)

The young mango orchard, which was started in November, 1923, contains 37 trees, representing 11 varieties. The trees were set alternately at 25-foot intervals in 3 rows 30 feet apart to form a wind-break on the northeast side of the citrus orchard, and have made good growth as the result of receiving good culture. The orchard is already of value for studying the habits of growth of new mango varieties, and should soon be of additional value for furnishing data on fruit production and resistance to adverse conditions, especially to attack from insect pests and fungus diseases. In an interplanting experiment, two rows of papayas 8 feet apart are being grown between rows of mangoes, with tomato plants 4 feet apart in the spaces remaining. (Fig. 3.) Several of the mango varieties produced fruit which matured in time for display in the horticultural exhibits at the Territorial fair.

During the early part of the fiscal year, 1,300 mango seeds were germinated, and the resulting seedlings grown in gallon tin containers to furnish rootstock material for grafting experiments in which form of union, age of material, and nature of growth were studied. Much of the surplus material was used in demonstrations and in trial plantings carried on in cooperation with experimenters in various parts of the Territory.



FIG. 2.—The Brindabani mango (accession No. 1372), a prolific Indian variety, but susceptible to attack by the fungus *Glaeosporium mangiferæ*



FIG. 3.—Young mango orchard interplanted with papayas and partly with papayas and tomatoes

## AVOCADOS

Cultural experiments with avocados are in progress at the Tantalus substation where conditions of altitude (1,000 feet) and rainfall are more suitable for the fruit than at the central station. The orchard contains nearly 100 trees representing numerous varieties of avocados. It is located in a clearing with the trees set in terraces along the contour lines of the mountain side. Many of the trees of the first planting of 1919 have already come into bearing. The later plantings have not yet begun to blossom. During the year many of the older trees blossomed heavily, but most of them failed to set fruit, probably because of the lack of sufficient moisture.

Young seedlings for propagating experiments are grown at the central station, and much of the stock is used in trying various forms of graft unions and in demonstration work. Several new varieties



FIG. 4.—Storey avocado (accession No. 5151), a West Indian variety grown by William Storey, Honolulu and now being propagated at the station. Fruit, oval-shaped, rich apple green, speckled; weight, 1 to 1½ pounds; rind, medium thick, rather tough; flesh, yellow, buttery, fiberless, nutty, and of pleasing flavor. Seed, loose in cavity and weighs 1½ to 2 ounces

were studied as to nature of fruit, and propagated by grafting methods. (Fig. 4.)

## PAPAYAS

Twelve different trial plantings, varying in number of plants from 15 to 185, are fruiting at the station (June 30, 1926). Each planting is from the seed of fruit representing some particular type, form, or character, such as is found in the Solo, a new strain from Samoa, the so-called Dapitan from the Philippines, and the "Cowley" from Queensland. Seven of the sex forms found among these plants have been described.<sup>1</sup> With the long-fruited, monoecious kind, 15 plants

<sup>1</sup>Hawaii Sta. Bul. 32, The Papaya in Hawaii.



FIG. 5.—Part of a plat of 35 papaya plants varying in form of plant and in form of fruit. The plants on the right are from seed of the Dapitan (accession No. 5097), the original of which was introduced from the Philippines in 1922. The two plants on the left are a part of a separate plat



FIG. 6.—Papaya plants in fruit. First two plants from seed of a long-fruited variety (accession No. 5103). Planted July 27, 1925, and photographed May 14, 1926. Note the two distinct shapes of fruit produced by flowers also of different form on tree on right

of a single accession number have shown as many as four of the sex forms. Some of the plants exhibit marked variations in nature of growth and form of fruit, showing not only differences in shape of fruit of individual plants (figs. 5 and 6), but also differences in shape of fruit on the same plant. Differences in shape, and oftentimes in color of flesh and flavor are probably not due to cross-pollination but to mutative conditions, which are delayed in some instances until a definite growth of plant has been made.

The average home gardener often has difficulty in getting seed to germinate and has better success with transplanted seedlings. The station prevents a shortage of various economic plants by maintaining for distribution to all parts of the Territory a supply of improved seedling varieties. During the year numerous requests for the papaya plants were filled by the division.

#### BANANAS

Varietal tests with bananas have been conducted both at the central station in Honolulu and at the Tantalus substation. Determining the relative resistance of several varieties to dry weather conditions probably was the most important work with bananas during the year. The Brazilian and Lady Finger varieties produced fairly good bunches of fruit, whereas other varieties bore fruit of unusually poor quality. Many of the plantings show signs of deteriorating, due to the length of time they have occupied the same clumps. Interest in banana culture is being renewed, and demands for the planting material are increasing.

During the year a bulletin on banana culture was submitted for publication.<sup>2</sup>

#### LITCHI

The litchi trees in the station orchard blossomed lightly and rather irregularly during the year. They produced normal foliage, but failed to set fruit. This condition prevailed rather generally with litchi trees in the Territory. Litchi trees require a very special culture in which fertilizers and water in abundance form an active part. About 150 seedlings were grown in gallon containers for use in budding experiments and in cooperative work with interested growers.

#### MACADAMIA NUT

Macadamia nut culture is assuming the proportions of an industry, which is as yet, however, in the experimental stage. Interest in the crop increased considerably during the year, and numerous requests were received for seeds and seedling trees. Areas devoted to the crop were extended on Oahu and in Kona, Hawaii. Several old trees at the Tantalus substation produced a light crop, the seed of which was utilized for propagation purposes. Resulting seedlings were used in cooperative experiments and for grafting experiments at the central station.

Fifty Macadamia trees which were planted at the Tantalus substation in December, 1921, are now 15 to 20 feet high. Approximately 50 trees, which were started in 1918 in cooperation with T. C. White at Kealakekua, Kona, Hawaii, came into bearing, and many of them

<sup>2</sup> Hawaii Sta. Bul. 55, Banana Culture in Hawaii.

are unusually tall. Experiments are under way to determine the effect of pruning on *Macadamia* trees under Kona conditions.

#### FIGS

Four varieties of figs are growing in the station orchard. The trees have been greatly reduced in vigor by the removal of cuttings for distribution to growers throughout the Territory. The propagating material is very much in demand for growing in home gardens. In Hawaii the fig is used as fresh fruit.

#### GRAPES

The vineyard, consisting of about 200 plants, was set out early in 1921. A number of vines of the Isabella grape, the original variety grown, have been grafted over to other varieties. Of 12 varieties now growing successfully, 6 have already fruited. During the year the vineyard was cultivated, pruned, fertilized, and sprayed. Several thousand cuttings were rooted for growing in cooperative experimental plantings. The cuttings can be rooted easily if they are placed in propagating beds of coral sand in the open sunlight. No difficulty was had in shipping the plants, either by mail or by freight, when the roots were properly packed in moist sphagnum moss.

#### TOMATOES AND ROSELLE

Considerable work was done with tomatoes and the roselle. Fourteen selections of tomatoes from crosses made two and three years ago have been grown in the hope of establishing hybrids with well-fixed characters. Seeds of a number of varieties from other countries have been tested and some of them indicate adaptability to Hawaiian conditions.

The roselle as a jelly fruit continues to be popular in Hawaii. The plant is an annual and is propagated from seeds. Owing to the difficulty of properly storing the seeds, many gardeners find themselves in need of a new supply when planting time arrives. Several thousand roselle plants were distributed by the station during the year.

#### PROPAGATION EXPERIMENTS

New plants at the station are propagated from seeds and by vegetative methods. Seedlings have been produced from the mango, papaya, citrus, grape, avocado, pomegranate, dates, *Macadamia* nut, guava, sapota, sea grape, pepper, carambola, star apple, and *Annona* species. Vegetative propagation methods have been successfully employed with the avocado, mango, citrus, breadfruit, fig, banana, mulberry, and litchi.

#### MISCELLANEOUS INTRODUCTIONS

Among the introductions of the year were grapes (several varieties), citrus (8 varieties), jujube, jaboticaba, avocados (3 varieties), dates (3 varieties), one of which received the first award at the Hawaii Annual Territorial Fair, 1925 (fig. 7), hickory nuts, papaw (*Asimina triloba*), Persian walnuts, cashew nuts, sunberry, Samoan and red-fleshed papayas, Queensland raspberry, seed of the new Burpee tomato, and root cuttings of a number of varieties of breadfruit from the Society Islands.

## HORTICULTURAL EXTENSION WORK

Demonstrations were carried on in the propagating house and in the field for the benefit of students of the public schools, the Kamehameha schools, and the horticultural classes of the University of Hawaii. Demonstrational work was conducted also to assist private growers both at the station and in various home gardens. Seven large experiments were continued in cooperation with private growers.

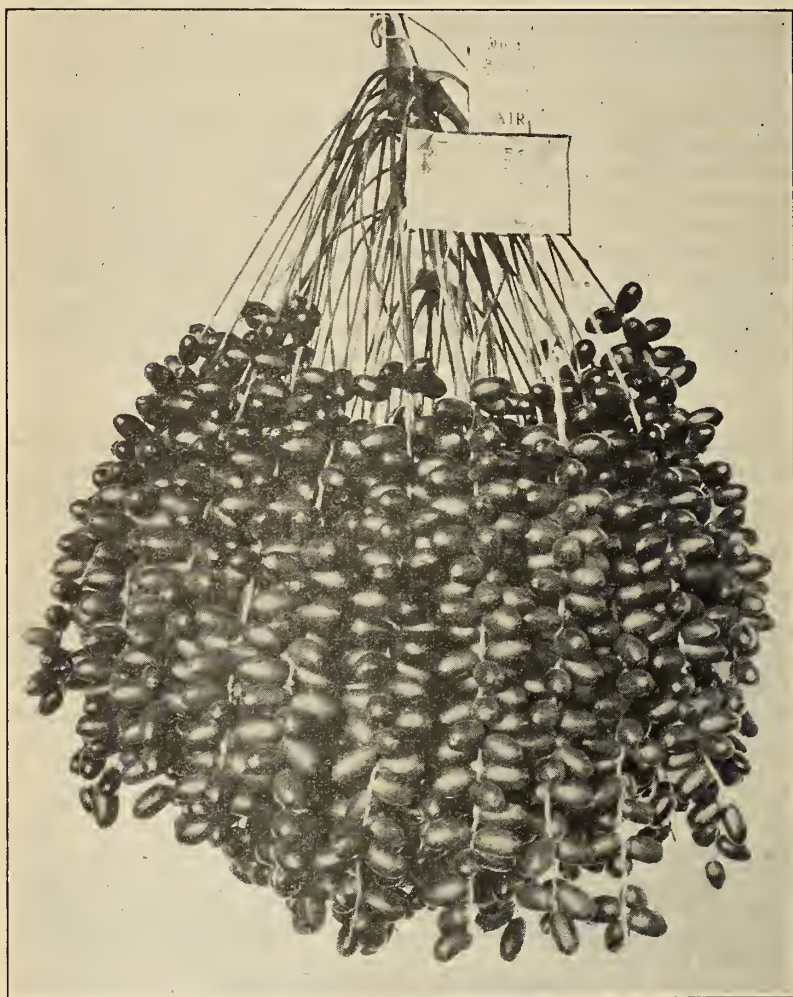


FIG. 7.—Dates from a seedling of the Deglet Noor variety, grown by Miss Steritt, Girls' Industrial School, Honolulu, and awarded the first prize at the Fourth Hawaii Territorial Fair. Weight, 56¼ pounds

The horticultural division was again the recipient of numerous requests for advice and information, and distributed bulletins and other printed matter of interest to local growers. The horticulturist acted as one of five judges who inspected 20 public-school gardens four times each on Oahu, and made side trips twice each to 16 individual home gardens which were under the care of school children

He also served as chairman of the committee on fruit exhibits at the Hawaii Annual Territorial Fair, and made a number of official trips to Oahu and Hawaii to assist in cooperative experimental work.

## REPORT OF THE AGRONOMY DIVISION

By H. L. CHUNG

### WHITE POTATOES

Three varieties of white potato, the Burbank, the Hamakua strain, and an unidentified sort resembling the Netted Gem, have been studied during the last two years to learn the relation of earliness to productivity. All three varieties yielded uniformly well notwithstanding the unfavorable weather prevailing at the time the crop was growing.

A small planting of the purple-skinned variety known locally as the "Portuguese Purple" was made for the purpose of restocking the seed supply. The variety bloomed profusely and seeded. So far



FIG. 8.—Sweet-potato breeding plat

as it is known, this is the first time any variety of potato has formed seed balls at the station (50 feet above sea level). The three varieties first mentioned also bloomed heavily, but formed no seed balls.

Two hundred pounds of choice station-grown potatoes were distributed for planting to growers of Palolo and Kailua, Oahu. The farmers of these places are cooperating with the station in establishing a fertilizer experiment with potatoes.

### SWEET POTATOES

Several varieties of promising sweet-potato seedlings bloomed simultaneously with a number of standard varieties. (Fig. 8.) Reciprocal crosses were made and produced a total of 321 seeds. The flower-bearing varieties bloomed profusely. Blooming usually ceases about April, but a large number of the plants continue to flower until the middle of May. Seedling No. 1804.1 is still producing flowers (June 30, 1926), which is rather late for the sweet potato in Hawaii.

## TARO

The Samoan variety of taro, or kalo (*Colocasia* sp.) which was received by the station last year, was harvested June 7 after a growing period of 13 months. Poi was manufactured from the crop at one of the local factories, and the quality compared with that of poi from locally grown taro. The Samoan variety is considered decidedly superior to the Hawaiian taro in consistency, but those who assisted in the palatability tests were divided in opinion so far as the taste is concerned.

Fifteen hundred taro plants of the Samoan variety were distributed to large and small growers throughout the Territory. It is hoped that more propagating material may be obtained for further planting. The taro cultural experiments were hampered by the drought, and the collection of varieties was transferred to the upper Tantalus substation in the hope that moisture conditions there would prove to be favorable to the crop. No distinct advantage was gained by the transfer, however, because of the general drought which lasted until about June 15.

## EDIBLE CANNA

Because of the increasing value of edible canna as a starch-producing plant and feed for livestock, cultural tests with the crop have been extended, especially at Waimea, Hawaii, under the immediate supervision of the chemical division. In the agronomy division crossbreeding was continued for the production of one or more promising seedling varieties or strains proving equal or superior in yield and quality to the commercial variety. These supplemental varieties will be held in reserve for use in case the ordinary variety is attacked by disease or insect pest, or deteriorates.

## GINGER

Unfavorable weather conditions and poor planting material retarded progress of the ginger projects. The plants showed signs of renewed growth with the occurrence of periodical light rains and cool mornings toward the close of the fiscal year. The project is to be repeated on a larger scale and in cooperation with a corporation at Kailua, Oahu.

Ginger is an important minor crop in Hawaii at present. Interest in the condiment has probably been stimulated by brisk demand from the mainland for the fresh roots for use presumably in manufacturing ginger ale.

## LETTUCE BREEDING

Seeds of a number of varieties of head lettuce were collected and planted to determine those which are best adapted to the warm lowlands of the island of Oahu. (Fig. 9.) The varieties Los Angeles "Best," Los Angeles "White," Iceberg, Immensity, Hanson, All-Seasons, May King, and California Cream Butter were grown in the first trial planting, and individual plants of the six varieties first mentioned were selected for hybridizing. Toward the close of the year a total of 233 crosses had been made and numerous seeds obtained.



FIG. 9.—Lettuce-breeding plat

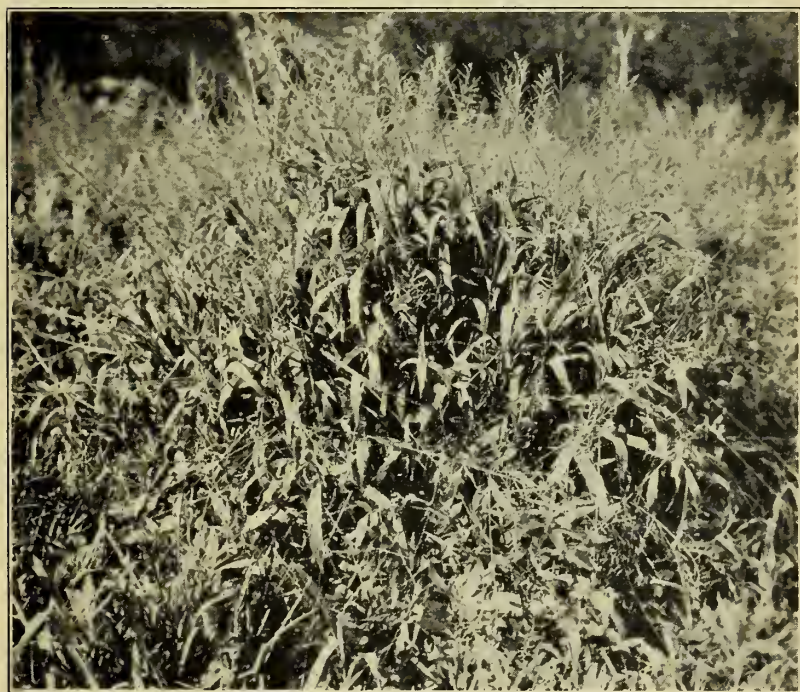


FIG. 10.—*Exophorus unisetus*, a promising pasture grass for Hawaii  
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## CORN

During the last two seasons crosses have been made with Guam corn and several varieties of sweet corn in the hope of developing a sweet variety combining stockiness with the ability to resist the corn leaf hopper (*Peregrinus maidus*) attack characteristic of the Guam variety. The best ears from the most prolific and stocky resulting plants were selected for further breeding work.

## FORAGE GRASSES

A fertilizer experiment was conducted with *Exophorus unisetus* (fig. 10), a promising grass for Hawaii, especially as a feed for dairy cattle and for poultry. Poultry and cow manure were included in the experiment to compare their relative efficiencies as fertilizers with the commercial kinds. Notwithstanding the dry weather prevailing, the demonstration grass areas were successfully maintained for the production of seeds and cuttings for distribution to ranchmen and to others who are interested in grasses.

## MISCELLANEOUS CROPS

Several varieties of radish (*Raphanus sativus*) and 10 strains of Chinese cabbage (*Brassica pekinensis*) have been under test at the station. Cabbage yielded at the rate of 5 to 30 tons per acre, and the large radish varieties at the rate of 11 to 35 tons per acre.

Plantings to replenish the seed supply for the planting season of 1927 were made of beans (*Phaseolus vulgaris*, 5 varieties), peanuts (*Arachis hypogea*, 3 varieties), Chinese spinach (*Amaranthus gangeticus*, 3 varieties), Jerusalem artichokes (*Helianthus tuberosus*), and sorghum (*Andropogon sorghum*).

## THE CHAYOTE AS A POSSIBLE TRAP FOR MELON FLIES

A study was made of the chayote as a possible trap crop for the melon fly (*Bactrocera cucurbitae*). Watermelon and cantaloupe growing is gaining in commercial importance, especially on Molokai, but successful culture of the crops is seriously retarded by the melon fly. Observations showed that the flies oviposit in large quantities on chayote fruits, but no live maggots were to be found on the same fruits when examined several days later. Further observations are necessary to determine definitely whether the chayote can be used in melon fields to help reduce infestation by the melon fly.

## DISTRIBUTION OF SEEDS AND CUTTINGS

Heavy demands were made upon the agronomy division for seeds and cuttings. A comparatively large part of the distribution was made to contestants in the school and home garden work and to homesteaders on Molokai.

Distribution of seeds and cuttings from July 1, 1925, to June 30, 1926, was made in quantities as follows:

*Seeds and cuttings distributed during the fiscal year ended June 30, 1926*

Crop	Seed	Cuttings	Crop	Seed	Cuttings
	Pounds	Number		Pounds	Number
Alfalfa .....	18	-----	Chinese spinach .....	3	-----
Beans .....	195	-----	Potatoes .....	200	-----
Cowpeas .....	37	-----	Edible canna tubers .....	3,000	-----
Corn .....	229	-----	Cassava .....	-----	96
Grass .....	7	-----	Napier grass .....	-----	1,700
Pigeon peas .....	35	-----	<i>Exophorus unisetus</i> .....	-----	5,086
Peanuts .....	110	-----	Sweet potatoes .....	-----	13,000
Lettuce .....	7	-----	Taro .....	-----	1,500

## REPORT OF THE CHEMICAL DIVISION

By J. C. RIPPERTON

## EDIBLE CANNA INVESTIGATIONS

## FIELD WORK

Experimental work with edible canna was continued on a field scale at the central station in Honolulu (figs. 11 and 12) and at Waimea, Hawaii. One crop was harvested during the year in an effort to learn the effect of varying the quantities of irrigation water on yield and manner of growth of crop and on the physical properties of canna starch. In another experiment, undertaken to learn the progressive growth of individual hills from the time of germination, each stalk is being tagged as it appears. Results so far indicate a decided cyclic rather than a continuous growth of hill. The experiments are to be duplicated at Waimea to learn if the cyclic growth is made there and what environmental factors cause it. The data may have a practical bearing on various factors including time of planting and of harvesting.

Experiments were begun to improve the species through individual selection. Whether the species is sufficiently pure to

preclude mass selection is not known, but the possibility is suggested by the very great differences in the size of adjacent hills from apparently similar seed. The work will be hastened by harvesting and by repeating the experiment at 6-month intervals, instead of 12 to 18 month periods.

Plantings of edible canna rootstocks from Queensland were harvested and the resulting seed was used in extending the area devoted to the crop.



FIG. 11.—A single hill of edible canna, 5 months old. Grown at the central station, Honolulu

Edible canna experiments, begun at Waimea, Hawaii, in July, 1923, in cooperation with the extension agent on Hawaii, are yielding conclusions of immediate value in altering present field practices with the crop. The experiments deal with tuber selection for planting, number of tubers per hill, the effect of spacing and depth on yield of tubers, the feasibility of mulching with canna tops, and the best time of harvesting and applying fertilizers. The crop was harvested during the year at 20 months from planting and yielded an average of about 35 tons of rootstocks per acre. This is nearly double the yield obtained at the central station, and points to the remarkable adaptation of the crop to the rather unusual soil and climate at Waimea.



FIG. 12.—Base of a hill of edible canna, 5 months old

In another experiment, occupying a 4.7-acre plat, several types of seed material giving the most promise in the above-mentioned experiment, were planted to determine the effect of continuous use on each. Seed was selected from corresponding plats in the first experiment and also from exceptionally large hills, vigorous lines, and from rootstocks of exceptional size and of high starch content. Studies are being made comparing the effect of age on "seed" and of storing the "seed" for varying lengths of time, and of the relative economy of planting single, selected "seed" with double unselected "seed." In addition, a 1-acre plat each is devoted to single "seed" and double "seed" plantings to determine the rate of growth of the crop by means of monthly harvests of one-tenth-acre plats.

A red variety of canna, which was found growing in an experimental field in 1924, was carefully studied because of its exceptional

vigor, heavy yields, and desirable habits of growth as compared with the common variety. (Figs. 13 and 14.) A number of hills of the red variety when sufficiently mature were harvested for determination of the starch content of the rootstocks. Starch was also extracted from a number of the rootstocks, its morphology was determined, and the viscosity compared with that of the starch of the common variety. The properties of the starches of the two varieties were found to be similar, but the percentages of actual starch in the red variety proved to be too low to make it desirable for starch making. Seed and rootstocks of the red variety were submitted to the agronomist of the station for use in crossbreeding.

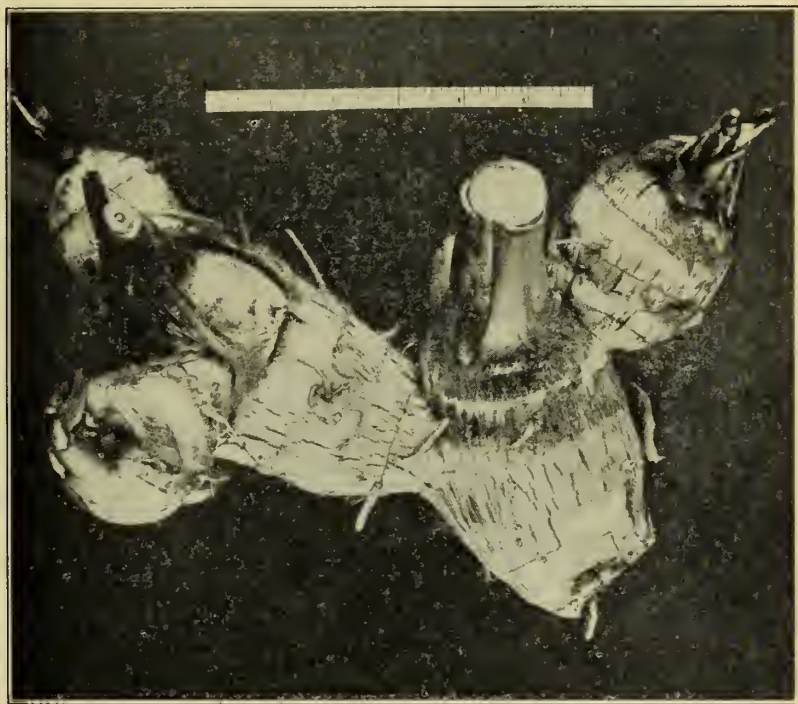


Fig. 13.—Edible canna rootstocks grown at Waimea, Hawaii. Weight,  $3\frac{1}{2}$  pounds

#### CARBOHYDRATE METABOLISM OF THE CANNA PLANT

Investigations begun during the fiscal year 1925 on the carbohydrate metabolism of the canna plant were completed and the results submitted for publication.<sup>3</sup> Sucrose was found invariably to predominate in the leaves of the plant. In proceeding down the stem, the sucrose decreases, whereas the hexoses rapidly increase, usually exceeding the sucrose. In the rootstock, sucrose again exceeds the hexoses, which decrease rapidly. The hexoses are therefore thought to be primarily concerned with translocation, and sucrose to be related to the photosynthetic process, and existing as an intermediate product

<sup>3</sup>Hawaii Sta. Bul. 56, Carbohydrate Metabolism and Its Relation to Growth in the Edible Canna.

between the hexoses and the starch, the final product. With relation to growth, the hexoses of the stem and the sucrose of the rootstock seem to correlate rather closely with the rate of storage of starch in the rootstock. Formation of starch continues normally in the rootstock until it becomes quite old, and the rate of translocation of sugars, as measured by the concentration of the hexoses, is at the maximum in the mature stems. A table has been constructed making it possible to determine in the factory the approximate percentage of starch in a rootstock from its specific gravity.



FIG. 14.—Rhizomes of a red variety of canna found growing in Waimea, Hawaii

#### MILL CONTROL METHODS

Two methods were developed for the control of the milling process in the starch factory. The first is an adaptation of the procedure used to determine the percentage of moisture in potato starch, and serves as a control of the moisture content of the starch in the drying tunnel. The second makes possible the determination of the viscosity of the finished product. An inexpensive pipette viscosimeter was devised for the purpose. This instrument is

capable of giving results that can be duplicated as closely as when a more expensive one is used.

#### EFFECT OF VARIOUS FACTORS ON THE PROPERTIES OF STARCH

Samples of canna starch which were collected from miscellaneous sources were found to vary greatly in viscosity. In the hope of producing a canna starch of uniform quality, work was begun to determine the effect on the starch of various factors including climate, age of crop, milling process, storage of rootstocks, wetting, and drying at different temperatures and humidities. Laboratory results are tried out in a local starch factory, which submits to the station for analysis the samples of starch obtained by the different procedures. (Fig. 15.)

#### MINERAL CONSTITUENTS OF EDIBLE CANNA

The excessive growth of the stems and rootstocks of the canna plant at Waimea must of necessity effect a heavy drain upon the soil. No appreciable response of the plant to fertilizer has been made thus far,

although the soils of the district have never been heavily cropped. A falling off in yield is certain to occur soon unless fertilizing material is systematically applied to the soil to maintain fertility. Samples of the stem and rootstock of various ages have been collected for determination of their chief mineral constituents, and samples of the pulp are being analyzed for determination of its fertilizer value.

#### POSSIBILITIES OF THE PULP AS A FEED

The apparent palatability of the waste pulp from the starch factory suggests the possibility of using the material as a carbohydrate feed either in the fresh state locally or in the dried state for export to the



FIG. 15.—Refining and drying room of edible canna starch factory

Pacific coast. Samples of the pulp are being analyzed to learn how it compares in feeding value with similar carbohydrate feeds on the market.

#### PRESERVATION OF HAWAIIAN FRUITS

Fruit growers, especially on the island of Hawaii, continue to show interest in the development of an export trade furnishing miscellaneous tropical fruit products to markets of the mainland. The island of Hawaii is capable of producing a wide variety of cultivated fruits. It has large areas of waste land on which the guava grows in abundance. Fruit production on Hawaii is greatly limited, however, by the difficulties entailed in shipping the fresh fruit to Honolulu, Oahu. The chemical division is rendering assistance to fruit-preserving concerns by submitting for their use plans for up-to-date preserving machinery and data and recipes regarding locally grown fruits, and by developing methods for testing juices for jelly-making qualities and for determining the physical properties of the jelly.

## COMPOSITION OF HAWAIIAN-GROWN VEGETABLES

Analyses were completed of a series of 60 different vegetables, chiefly of oriental origin. Determinations were made of their nutritive constituents, and of calcium, phosphorus, iron, total ash, and alkalinity of ash, and the results are being prepared for publication in cooperation with the agronomy division. The results strikingly show that Hawaii can and does produce a large variety of vegetables which are rich in all the necessary food and mineral constituents.

In connection with the tri-local vegetable experiment, analyses are being made of the second season's crop of vegetables grown on the mainland (Virginia and Oregon) and in Hawaii (Mokuleia, windward Oahu, and Honolulu).

## HALEAKALA SUBSTATION AND DEMONSTRATION FARM

By H. F. WILLEY

At the Haleakala substation and demonstration farm  $2\frac{1}{2}$  acres of gulch land was cleared and made available for pasture. Wires were

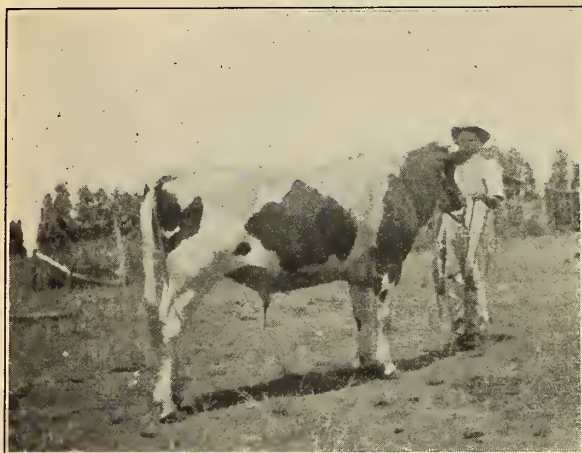


FIG. 16.—Holstein bull, Haleakala demonstration farm

strung on 40 rods of new fence. Two hog houses, one brooder house, and four small poultry houses were built, and 250 feet of pipe was laid to furnish water for the poultry and the livestock. A registered Holstein bull (fig. 16) and a purebred Duroc-Jersey boar are kept for community service. Approximately 149 varieties of 42

crops are under test, including pineapples, pigeon peas, oats (fig. 17), field corn, sweet corn, pop corn, broomcorn, tomatoes, strawberries, squash, beans, sweet potatoes, edible canna, dry-land taro, cassava (fig. 18), forage grasses, and fruit trees. Distributions were made of approximately 26,000 cuttings of sweet potatoes and coarse grasses, 500 rootstocks of edible canna, 700 strawberry plants, and numerous small lots of seed of pigeon peas, beans, corn, tomatoes, and taro. Trees that were planted during the last four years on the windward side of the farm are now of sufficient size to form efficient windbreaks (fig. 19), and serve to demonstrate the possibilities of such plantings on wind-swept grasslands. Plantings for windbreaks, especially of *Eucalyptus robusta*, are being increased.

The superintendent assisted in the pig and garden club activities, served as one of the judges of the garden contests, and also of the

exhibits at both the Maui County Agricultural Fair at Kahului and the Territorial fair at Honolulu, and acted as agricultural representative for the Maui County Chamber of Commerce. He also assisted

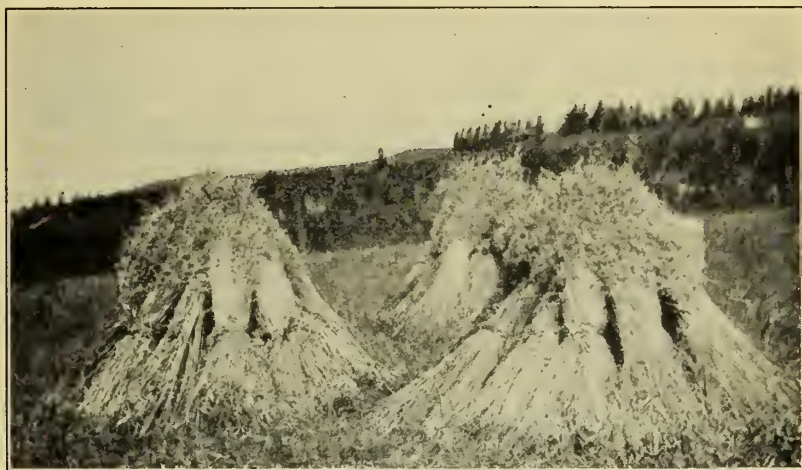


FIG. 17.—Sheaves of Red Texas oats harvested May, 1926, Haleakala demonstration farm

numerous farmers in solving farm problems, including obtaining and growing suitable varieties of crops, outlining methods of planting and



FIG. 18.—Roots of cassava planted June, 1925, and harvested June, 1926, Haleakala demonstration farm

harvesting, and marketing farm products. He aided the representative of the Smith-Hughes Vocational Education Act by demonstrating locally adapted methods of handling crops and livestock.

## REPORT OF EXTENSION AND DEMONSTRATION WORK ON THE ISLAND OF HAWAII

By R. A. GOFF

### EXTENSION OF CULTURE OF THE EDIBLE CANNA

Some progress was made in the development of the edible-canna industry in the Waimea district. The area in the crop was extended, and a starch-extracting mill and refining plant were erected. A large number of the homesteaders on Hawaii should benefit from the establishment of the industry, because the crop thrives at high altitudes and can be grown in places which have been prevented by strong winds



FIG. 19.—Windbreak trees planted October, 1922, and photographed May, 1926, Haleakala demonstration farm

from being utilized for anything but grazing. In a number of experimental plantings made at Waimea in cooperation with the chemical division of the station, part of the edible-canna crop is being harvested monthly to determine increase in yield from the use of various fertilizers, optimum time of harvesting, and depth and distance of planting. Crops are being grown also for seed selection. Plantings of small plats of edible canna have been made at various elevations and in different districts to learn the adaptability of the crop to various climatic and soil conditions.

### BOYS' AND GIRLS' CLUBS

Boys' and girls' club work, including livestock-production clubs, field-crop production clubs, and domestic science clubs, was organized in the fall of 1925 in schools on the east side of the island of Hawaii. Meetings were held at the schools, club projects were inspected at the homes of members, and instructive demonstrations were given by the local club leader for the benefit of the club members. The advice and instructions given were recorded for future use. Boys who have belonged to some particular club for two years are being encouraged to join other kinds of clubs to gain a general knowledge of the different branches of livestock and crop production fostered by the various clubs. Many of the club members who through force of circumstances will have to leave school before finishing may devote their future energies to cane growing with pig and chicken raising as a side line. Club work affords splendid opportunities for school children to learn how to avoid making the costly

mistakes invariably made by beginners. This is true especially in poultry raising. Boys leaving school in the Territory have been erroneously led to believe that they can not acquire farming land even when they have earned and saved sufficient money to make the purchase. When land is available it can be purchased by any boy on the island of Hawaii having the requisite sum to pay for it. Club work is developing interest in agriculture among the boys and shows them the possibilities they have of earning a living in their own districts instead of having to work in town at some poorly paid job or work with gang labor for some large company.

#### SCHOOL FAIRS

Club members entered livestock and corn exhibits at the fair held by the Honokaa Junior High School. The extension agent acted as one of the judges of the school fair and assisted club members in bringing the exhibits to and from the fair. At another school fair, held in connection with the American Legion Industrial Fair at Hilo from May 20 to May 22, inclusive, livestock exhibits, including chickens, pigs, rabbits, pigeons, and calves, were entered by members of the boys' clubs and sewing exhibits by members of the girls' clubs. The extension agent acted as chairman of the agricultural section and had charge of the transportation, housing, and care of the animals on exhibition.

#### SCHOOL AND HOME GARDEN WORK

The extension agent frequently visited and finally acted as judge in the home garden work undertaken by club members in connection with the Territorial school garden contest. In the earlier visits he gave advice to the young gardeners concerning seed, fertilizers, record keeping, methods of combating garden pests, and marketing; and he also assisted the children in obtaining improved varieties of seed. In the later visits he gave advice on seed selection and summer planting.

#### GRASS DEMONSTRATION WORK

Plats demonstrating five or six varieties of forage crops and range grasses proving best adapted to local conditions were maintained or started at some of the schools. Farmers living near the schools were taken to the demonstration plats, helped to select the crops found to be best suited to their particular needs, and given seed with which to start the crops.

#### ASSISTANCE IN POULTRY RAISING

The extension agent visited various poultry farms and the homes of individuals raising small flocks for home use or as a side line to some other branch of farming, gave advice on feeding for increased egg production and regarding sanitation, and distributed plans for poultry-house construction. He also showed poultry raisers how to cure certain poultry diseases. Successful poultry raising is extremely difficult on the island of Hawaii because a large percentage of the birds is carried off by disease during rainy periods.

#### ASSISTANCE IN ORDERING SEED

Catalogues of reliable seed houses were loaned to homesteaders and ranchmen, advice and assistance in ordering good varieties of seed was given farmers, and seed and cuttings of pasture grasses

and perennial forage crops were distributed from the Kamuela cooperative experiment station, which is operated by the Parker ranch, to farmers living in all parts of the island.

#### DISTRIBUTION OF LITERATURE

United States Department of Agriculture Farmers' Bulletins and circulars were distributed to farmers from the office and by the extension agent on his trips over the island. Newspapers and magazines containing interesting articles on poultry, pigs, dairy cattle, and gardening were loaned to various farmers.

#### ASSISTANCE IN MARKETING

Demonstrations were given producers in methods of grading and packing farm products for shipment to the Hilo and Honolulu markets. Wholesale houses have standing orders with coast firms for a part of the produce consumed locally, but usually are willing to cancel these orders when well-timed arrangements can be made with local growers. The products are marketed with difficulty when the arrangements are made too late to be of avail. Cold-storage facilities were arranged for perishable products failing to find a ready market.

#### PLANTING WINDBREAKS

Over 4,000 trees were taken from the Territorial nursery at Hilo for distribution to farmers living in the Kolaha and Waimea districts, where strong winds blow during a large part of the year. These districts are 20 miles or more from the railroad and the residents have difficulty in procuring trees for windbreaks.

#### ASSISTANCE IN BOY SCOUT ACTIVITIES

The extension agent again acted as examiner for members desiring to qualify for agricultural merit badges and as scout commissioner for the island of Hawaii. Bulletins dealing with agricultural topics were distributed to Boy Scout troops at the posts for use in their libraries. Over 50 badges were distributed to those competing for agricultural merit badges.

#### TRAVELING

The extension agent traveled approximately 10,000 miles visiting farms, schools, truck gardens, ranches, and plantations on the island of Hawaii. He visited when possible every farm in each section one or more times during the year. In June, 1926, he made a trip to the central station in Honolulu for the purpose of establishing contacts with the station workers and of familiarizing himself with the latest developments along agricultural lines.

#### BOYS' AND GIRLS' CLUB WORK

By MABEL GREENE

#### STANDARD CLUBS

The boys' and girls' 4-H standard clubs of the islands are distributed as follows:

*Enrollment of boys' and girls' clubs, June 30, 1926*

Club	Distribution				Total
	Hawaii	Kauai	Maui	Oahu	
Canning .....	0	0	25	15	40
Cane (sugar).....	25	0	0	0	25
Clothing .....	336	0	84	432	852
Cooking .....	58	0	0	31	89
Garden .....	53	33	26	75	187
Pig .....	23	0	15	0	38
Potato .....	0	0	4	25	29
Poultry .....	16	0	0	24	40
Rabbit .....	21	1	0	0	22

## FAIRS AND DEMONSTRATIONS

Members of the boys' and girls' clubs have entered exhibits in activities carried on in cooperation with school fairs and the Parent-

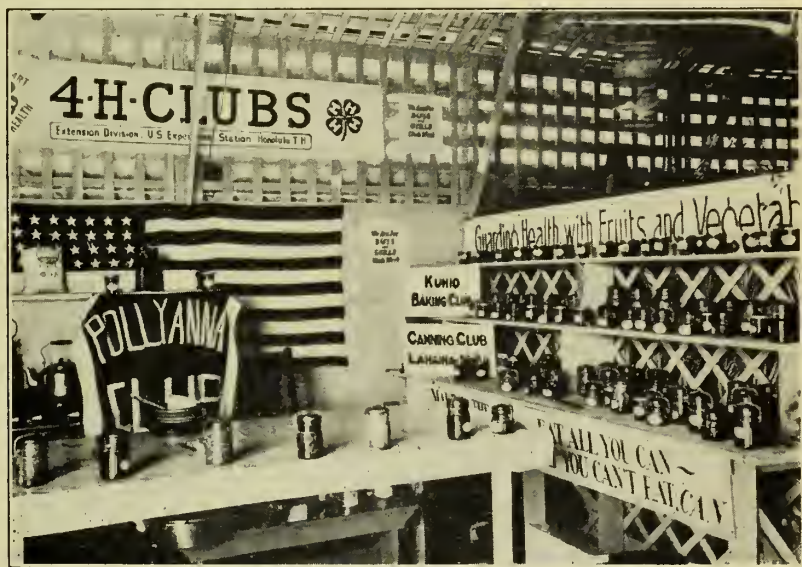


FIG. 20.—4-H clubs' exhibit, Educational Building, Hawaii Territorial Fair, Honolulu, August 31, to September 9, 1925

Teachers' Association. A demonstration in "good buymanship," a study of textiles, was given by two clothing club girls at one of the meetings of the Parent-Teachers' Association in the Kauluwela School, Honolulu. The demonstration was given in English and then in Chinese and Japanese for the benefit of the group of oriental mothers attending. Local fairs were held at Honokaa, Laupahoehoe, Hawaii. Seven boys from the Honokaa pig club exhibited pigs which they raised, and recorded the gains made per pig and the cost per pound of gain. Both the girls' and the boys' club work was judged.

At the last Territorial fair space was allotted club exhibits in one of the educational buildings (fig. 20), and members participated in contests during each of the nine days of the fair. After the fair the

Pollyanna Club sent canned locally grown fruit to Chicago for exhibition at the canning exhibit of the National Boys' and Girls' Club Congress, held from November 30 to December 5, 1925. The fruit exhibit was much appreciated and three members of the club were awarded 3 dozen glass jars by a glass-jar company entering its jars for contest at the congress. The jars are being filled for the coming fair by the club girls, and as an award did much to stimulate interest among the girls in food preservation. The Pollyanna Club held five sales of jellies, jams, and marmalades from Hawaiian fruits. The club leader attended the Fourth National Boys' and Girls' Club Congress at Chicago where many exhibits were entered for contest, 1,200 members of 4-H clubs were assembled, and a large number of club leaders from 42 States were present.

Excellent agricultural clubs were organized during the year on Kauai. These are ready for 4-H club work next year. The boys of the Hanamaulu School have done garden work for two years. The girls are eager for a home economics club or for any other kind of club which in the opinion of the school principal will benefit the community. Garden work is very successful on Kauai, which is known as the "Garden Isle," and ample land is available for gardening. The club leader frequently inspected the children's gardens, which often occupied the better part of the home garden plat. The parents were interested in the work being done and appreciative of the club leader's efforts to develop the spirit of gardening in the children, and the teachers reported increased interest in each school where a club has been located. The gardens themselves are better than ever before.

#### CLUB RECREATIONAL ACTIVITIES

Agricultural lantern slides were shown at meetings of two club groups, and achievement pins were awarded when possible at public school assemblies for finished club work as reported in the club record books. Some of the club records are better kept and more complete than were those of last year. The food habit score card has been kept in the record book of many members of the cooking clubs, preparatory to carrying on health work next year. Some of the girls are excellent bread makers, and report purchasing such home equipment as ovens, stoves, measuring cups, and spoons. Bread is now made in homes where formerly rice was served as the chief cereal food. The boys as well as the girls are doing canning work in Haiku, Maui. One of the boys, who has done club work for two years, is planning to raise poultry for market to defray his expenses through high school. Four 4-H home economics clubs were organized by a teacher in the International Institute of the Young Women's Christian Association. The girls are doing more satisfactory work than some of the mothers, many of whom are handicapped by foreign customs and a lack of knowledge of English.

Room improvement club work was started in Honolulu for senior high school girls wishing to improve their homes during the summer vacation period. The girls are making curtains, rugs, dresser covers, and box furniture, and in some instances are refinishing old furniture.

Several commercial companies are cooperating in club activities by furnishing merchandise prizes as awards to successful competitors in club contests and fair exhibit work.